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A preliminary study of the Upper Cretaceous of the Western Tarim Basin (South Xinjiang, China) with special reference to its transgressions

By

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With 2 text figures and 1 plate

ABSTRACT

Western Tarim Basin, S. Xinjiang is one of the most important regions for study of marine Cretaceous in China. The Upper Cretaceous strata are widespread and well developed with about 500 m thickness. They are composed of two transgression cycles and contain a great variety of fossils, more than ten groups in total.

The Late Cretaceous faunal assemblages in this area belong to the Eastern Mediterranean Subprovince of Tethyan Realm. On the whole, they show the same features as those in the Central Asia of USSR. The seawater from Tethys sea having invaded at least twice eastward the Tajik Basin in Central Asia of USSR entered into the Western Tarim Basin by way eastward of the Alai mountain valley.

KURZFASSUNG

Das Tarim Becken in Süd-Xinjiang (NW-China) ist eines der wichtigsten Gebiete zur Untersuchung der marinen Kreide Westchinas. Die Oberkreide ist weitflächig aufgeschlossen und erreicht 500 m Mächtigkeit. Die Abfolge zeigt 2 Transgressions-Zyklen und enthält eine reiche Fauna mit Vertretern aus mehr als 10 Gruppen. Die Oberkreide Faunen-Vergesellschaftungen gehören paläobiogeographisch zur Ostmediterranen Subprovinz der Tethys; sie zeigen große Ähnlichkeit zu gleichalten Ablagerungen im zentralasiatischen Teil der USSR. Das Meer aus der Tethys griff mindestens zweimal ostwärts über das Tajik Becken (Zentralasien, USSR) hinaus und gelangte nach Osten über die Alai-Gebirgs-Furche bis in das westliche Tarim Becken.

INTRODUCTION

Situated in Northwestern China the Western Tarim Basin is one of the most important regions for the study of marine Cretaceous strata in China, where the Upper Cretaceous is widespread and dominated by marine sediments. Over the past two decades, various prospecting teams from the petrogeological departments have made contributions to the classification and correlation of the Upper Cretaceous, establishment stratigraphical and paleontological sequences, naming formations and looking into the problem of transgressions.

According to previous authors, the Upper Cretaceous consists ascendingly of such formations as Kukebai, Wuyitake, Yigeziya and Tuyilouke, characterized mainly by terrigenous clasts, carbonate rocks and evaporites, in association with plenty of bivales, ostracods, foraminifera, gastropods, serpuloidea, ammonites, echinoids, brachiopods, bryozoans, dinoflagellates, calcareous algae and sporo-pollen, some of which, however, have not yet been studied. The Kukebai Formation yields fossils in great abundance, and the Yigeziya Formation comes next. In the Wuyitake Formation occurs

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sporo-pollen, while in the Tuyilouke Formation appear only fragmentary remains. As a result of our study, it is suggested that the ages of the above formations are Cenomanian, Turonian, Turonian-Senonian, Senonian-Maastrichtian and Maastrichtian respectively.

This paper was the results from a field investigation during the summer of 1980 in such counties as Ulugqat, Yengisar and Yarkant in southern Xinjiang (Fig. 1). Here is a brief account of the Upper Cretaceous biotic aspects as well as its transgresions.

STRATIGRAPHY

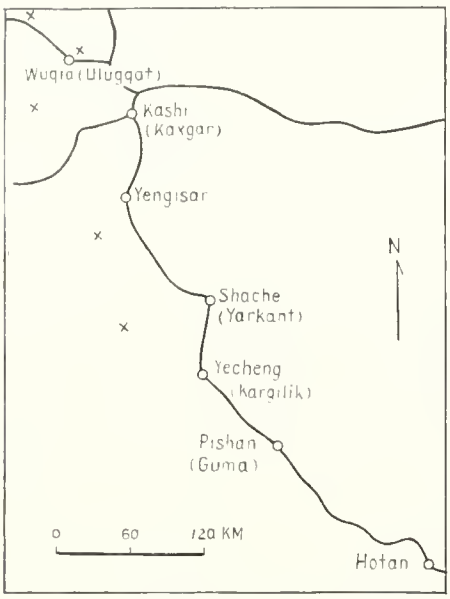

Fig. 1. Location of study area in Western Tarim Basin, S. Xinjiang.

In W Tarim Basin, the Upper Cretaceous is widely distributed along the foot of southern Mt. Tianshan and Mt. Kunlun. The strata, about 500 m thick, are well exposed and distinct in sequence. Generally, there is an extensive spread of fossil groups with a remarkable vertical variation.

Based on lithology and fossils, the Upper Cretaceous may be divided into four formations, commonly conformable with each other. The stratigraphical sequence in ascending order is as follows:

Kukebai Formation. This formation conformably overlies the continental Lower Cretaceous Kezelesu Group, which may be subdivided into two members.

Lower Member: This member, 93,61 m thick, may be subdivided into four parts: grey whitish fine sandstones at the base, variegated silty mud stones, mud stones intercalated with dolomites and gypsums in the lower part; grey biomicrites in the middle and dark grey mud stones intercalated with dolomites in the upper. At the very base an imprint of marine bivales *Anadara* was found for the first time. In the middle and upper part there occur abundant fossils, including foraminifers *Orientalia exilis* Bykova, etc., commonly known from the Cenomanian in Central Asia of USSR.; bivalves *Rhynchostreon* and *Planocaprina* (Akeche section) etc., known from the Cenomanian–Turonian in Asia, Europe and America, and from the Albian–Cenomanian in Mexico and other countries respectively; ostracods *"Cytherettinella"*, etc., known from the Cenomanian–Turonian in Central Asia, USSR; dinoflagellates *Cyclonephelium vanophorum* Davey, etc., known mainly from the Cenomanian in Britain and Canada. Besides, the rich sporo-pollen characterized by the *Interulobites-Taurocusporites* assemblage, which is chiefly composed of *Schizaeoisporites* spp., *Interulobites* spp., and *Taurocusporites* spp., and is especially predominated by Pteridophyta most probably of Cenomanian age. The age of the above-mentioned fossils tends to be Cenomanian and, consequently, the Lower Member of the Kukebai Formation is regarded as the Cenomanian.

Upper Member: On the basis of the lithofacies and biotic assemblages, this member, attaining a total thickness of 83,87 m, is subdivisible into two parts. The lower part consists of grey *Ostrea*-limestones, while the upper part is composed of dark grey mud stones intercalated with biomicrites, yielding very abundant fossils, some of which such as ammonites, gastropods, etc., are present only in a few beds. The bivalves in the lower part are represented mainly by *Ostrea delettrei* Coquand, forming a coquina bed, known from the Turonian in Central Asia, decreasing upward in numbers and replaced by plenty *Trigonia (Korobokovitrigonia)*, *Trigonarca*, etc., the former being found from Barremian-Turonian in Central Asia, Algeria, Spain and other countries, while the latter from the Upper Cretaceous in India, Africa, Europe and America respectively. The ammonites represented here by *Thomasites* occurs widely in the beds of Tethyan region generally thought to be early Turonian, with records from Algeria, Egypt, Lebanon, Syria, Spain, southeastern France, Nigeria and Turkestan. The ostracods assemblage containing *Schuleridea atraxa* Mandelstam et Andreev, *"Cytherettinella" mandelstami* Andreev, *Alatacythere turonica* (Mandelstam), *"Tetisocypris" proceraformis* (Mandelstam), *"Bronsteiniana"* sp., etc., known from Turonian in Central Asia of USSR., also shows similarities to those in Egypt and other coastal Mediterranean countries. Gastropods such as *Helicaulax securifera* (Forb.) is found from the Cenomanian-Turonian in India. Dinoflagellates *Odontochitina operculata* (Wetzel), is known as the zonal fossil from Campanian in E Canada and Texas of USA. Sporo-pollen characterized by *Trisolissporites-Cranwellia* assemblage contains mainly *Schizaeoisporites* spp. and *Trisolissporites* spp., etc., in which the quantity and species of Angiosperm were on the increase, suggesting an age of Turonian. Judging from ammonites and other fossils, it is preferable to assign the Upper Member of Kukebai Formation to the Turonian age.

Wuyitake Formation: This formation, 87,11 m thick, may be subdivided into four parts: grey greenish, dark brown argillaceous siltstones and silty mud stones intercalated with thin-and thick-bedded gypsums in the lower part; white

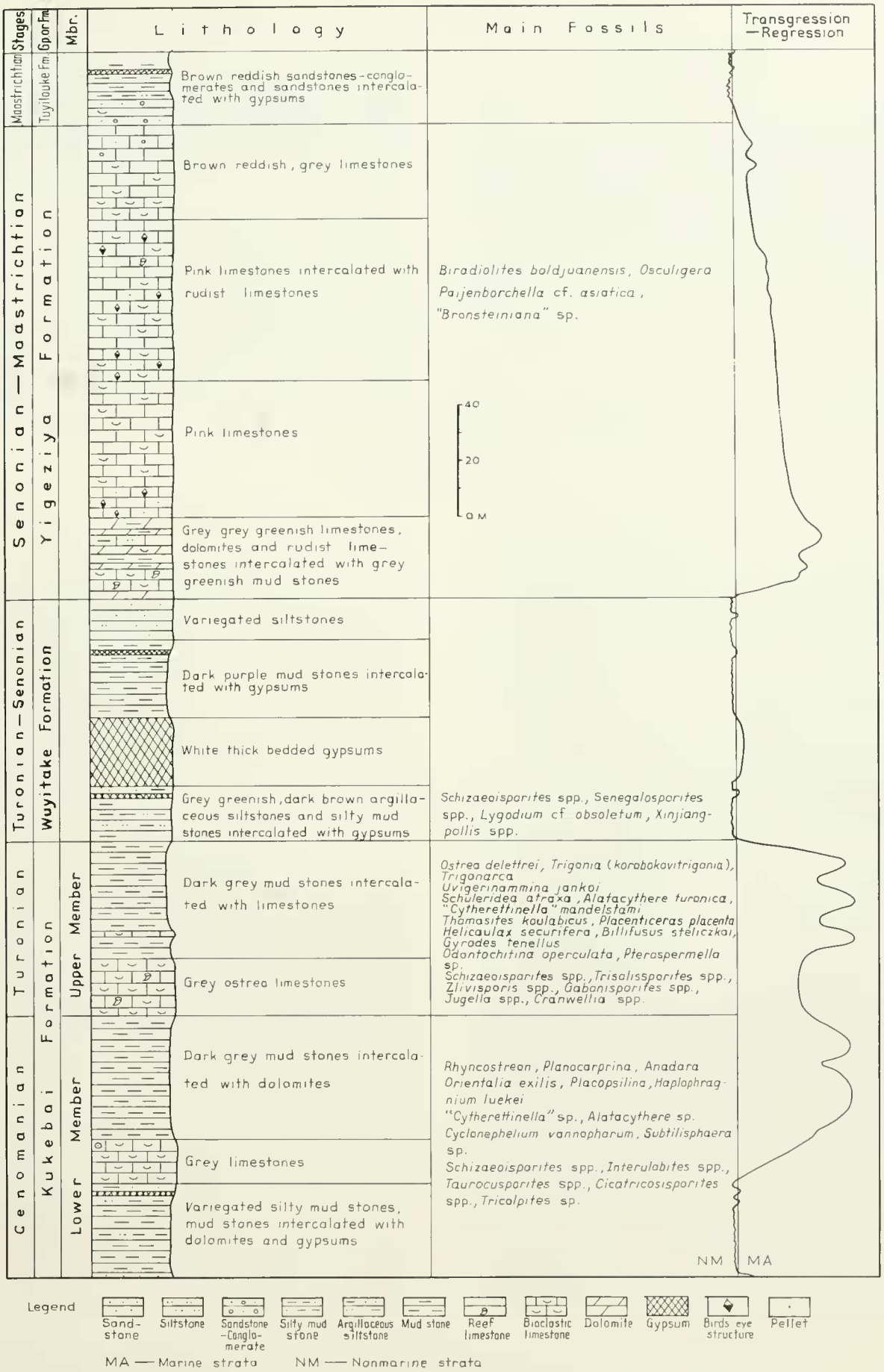

Fig. 2. Schematic Stratigraphy of the Upper Cretaceous in Ulugqat and Yengisar districts, S. Xinjiang.

thick-bedded gypsums in the middle; dark purple mud stones intercalated with gypsums in the upper and variegated siltstones at the top. So far only sporo-pollen has been found in the lower part, consisting mainly of *Schizaeoisporites* spp., *Senegalsporites* sp. and *Lygodium* cf. *obsoletum*, in which the Pteridophyta is predominant, bearing the same assemblage as that of the Upper Member of Kukebai Formation. However, the Angiosperm becomes even more abundant both in quantity and in species, its age still belonging to Turonian. Taken into account the sporo-pollen in the lower part as well as the age of the overlying Yigeziya Formation, the Wuyitake Formation seems to belong to Turonian-Senonian.

Yigeziya Formation: According to the lithological characters, this formation, with a total thickness of 162 m, may be subdivided into four parts: grey, grey greenish bioclast-bearing micrites, calcareous microcrystalline dolostones bearing bioclasts and rudist limestones intercalated with grey greenish mud stones in the lower part; pink bioclast-bearing micrites in the middle; pink forams-bearing micrites with birds eye structure intercalated with a few reddish limestones in the upper and brown reddish, grey bioclast-bearing micrites at the top. The rudists mainly found in the lower and upper parts, carry *Osculigera* and *Biradiolites boldjuanensis* Bobkova, the former being known to exist from the Senonia-Maastrichtian in Iran, while the latter from the Maastrichtian in Central Asia of USSR. Ostracods such as *Paijenborchella* cf. *asiatica* Andreev in the lower part was originally reported from the Campanian-Maastrichtian in Central Asia, USSR. Based on the bivales and ostracods, this formation may belong to the Senonian-Maastrichtian age.

Tuyilouke Formation: This formation, about 80 m thick, is disconformably or unconformably overlain by the Paleocene Aertashi Formation. It consists of brown reddish sandstones-conglomerates and fine to medium-grained sandstones intercalated with gypsums, with a few fragments of foraminifers, bryozoans, echinoids and gastropods. From the ages of the underlying and overlying formations, the Tuyilouke Formation may be presumably assigned to the Maastrichtian age.

TRANSGRESSIONS AND REGRESSIONS

Based on the characteristics of the depositional formation of strata, lithology and fossils (fig. 2), the Upper Cretaceous is divided into two cycles of transgressions-regressions: the first cycle ranging from the Kukebai Formation to the Wuyitake Formation, and the second from the Yigeziya Formation to the Tuyilouke Formation.

In the first cycle the base of Kukebai Formation consists mainly of terrestrial deposits along with some gypsums and a few marine beds, indicating the beginning of transgression, then followed by grey biomicrites – dark grey mud stones – grey *Ostrea*-limestones – dark grey mudstones, representing the main phase of the transgression. The fossils contained in the formation are dominated by benthonic and some planktonic faunas, such as ostrea, bryozoans, serpuloidea and ammonites, a fact which suggests that the depth of seawater oscillated between the shoal and the basinal gulf of shallow sea. In the Wuyitake Formation there are variegated sandstones and mud stones intercalated with several gypsum beds, reflecting an accumulation mainly in a lagoonal environment as a result of regressions. Results of sporo-pollen analysis show that the first cycle was deposited under tropical and subtropical conditions, while the presence of gypsums at the early and later stages was attributed to an arid climatic condition.

The second cycle differs somewhat from the first cycle in being presented by transgression carbonate rocks of the Yigeziya Formation, which consist of grey biomicrites and rudist limestones intercalated with a few mud stones, showing that the transgression had reached its peak. The continuation of transgression and the shallowing of depositional environment is evidenced by pink biomicrites and pellet micrites, wherein the birds eye structures and some rudist limestones sometimes occur, indicating a rather shallow-water environment under upper subtidal to intertidal condition, occasionally restricted to the subtidal range, that is to say the seawater starting to retreat. The Tuyilouke Formation consists of brown reddish sandstones – conglomerates and bioclast – bearing micrites intercalated with gypsums, carrying fragments of foraminifers, etc., indicating the beginning of regressive stage, presumably to be deposited under rather hot and arid tropical environments.

From the foregoing, it is clear that after a long period of continental deposition in Jurassic and Early Cretaceous, there were twice moderate transgressions in this region, one ranging from Cenomanian to Turonian, the other from Senonian to Maastrichtian. The seawater from the Tethys having invaded eastward the Tajik Basin in Central Asia of USSR entered into the depression between southern Mt. Tianshan and Mt. Kunlun of China by way eastward of the Alai mountain valley, extending eastward again to the east of Ulugqat, turning to the southeast and reaching finally to southeastern Guma, forming a long and narrow shallow gulf.

In W Tarim Basin, the Late Cretaceous transgressive-regressive pattern chart indicates that T7 (Global transgressive [eustatic] peak terms of Hancok and Kauffman, 1979) stands for the regression, whilst T6, T8 and T9 the peak of transgression. These figures are approximately in coincidance with those in Kauffman (1981) NE and NW China chart, but rather differ from those in the Global and S-Tibet ones in which T7 represents a transgressive peak, while T8 and T9 refer to two minor transgressive peaks.

CONCLUSIONS

1. On the whole, the Upper Cretaceous faunal assemblages (see pl. 1) in this region show the same features as those in central Asia of USSR. They are mainly endemic in forms, belonging to the Eastern Mediterranean Subprovince of Tethyan Realm, differing, however, from that of the Southern Tibetan Subprovince.

2. During the Late Cretaceous the seawater from the Tethyan sea having invaded eastward the Central Asian region of USSR entered seperately into the western Tarim Basin by way of the Alai mountain valley, forming a gulf of shallow sea, which was the easternmost locality of the Tethys in S. Xinjiang and which was twice undergone transgressions and regressions differing somewhat from those of the global events in the late Cretaceous period.

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Plate I

The biotic assemblages of the Upper Cretaceous of the Wetsern Tarim basin, Xinjiang.

The Lower Member of Kukebai Formation:

1– 2. *Anadara* sp.
3. *Placopsilina cenomana* D'ORBIGNY
4. *Orientalia exilis* BYKOVA
5. *Cyclonephelium vanophorum* DAVEY
6– 7. *Tauroscusporites* spp.
8–10. *Interulobites* spp.
11–12. *Cicatricosisporites* spp.
13–14. *Schizaeoisporites* spp.
15. *Tricolpites* sp.
16. *Classopollis* sp.

The Upper Member of Kukebai Formation:

1– 3. *Placenticeras placenta* DEKAY
4– 6. *Thomasites koulabicus* (KLER)
7. *Trigonia (Korobokovitrigonia) ferganensis* ARHK.
8. *Ostrea delettrei* COQUAND
9. *Trigonarca passyana* (D'ORBIGNY)
10. *Gyrodes tenellus* STOLICZKA
11. *Helicaulax securifera* (FORB.)
12. *Billifusus stoliczkai* (COLLIGNON)
13. *Uvigerinammina* sp.
14. *„Tetisocypris" proceraformis* (MANDELSTAM)
15. *Schuleridea atraxa* MANDELSTAM et ANDREEV
16. *„Bronsteiniana"* sp.
17. *Alatacythere turonica* (MANDELSTAM)
18. *Brachycythere* sp.
19. *„Cytherettinella" mandelstami* ANDREEV
20–22. *Odontochitina operculata* (WETZEL)
23–26. *Schizaeoisporites* spp.
27. *Trisolissporites* spp.
28. *Zlivisporis* sp.
29. *Gabonisporites* spp.
30–31. *Cycadopites* spp.
32. *Jugella* sp.
33. *Cranwellia* sp.

The Wuyitake Formation:

1. *Lygodium* cf. *obsoletum* E. IV.
2– 3. *Schizaeoisporites* spp.
5– 6. *Xinjiangpollis* sp.
7. *Pentapollenites* sp.

The Yigeziya Formation:

1– 2. *Osculigera* sp.
3– 4. *Biradiolites boldjuanensis* BOBKOVA
5. *„Cytherettinella"* sp.
6. *Brachycythere* sp.
7. *Xestoleberis* sp.
8. *Paijenborchella* cf. *asiatica* ANDREEV
9. *„Bronsteiniana"* sp.

Cenomanian	Turonian	Turonian-Senonian	Senonian - Maastrichtian	Maastrichtian
Kukebai Formation		Wuyitake Formation	Yigeziya Formation	Tuyilouke Formation
Lower Member	Upper Member